Wafer Inspection Device

The invention relates to a device for wafer inspection. In particular, the invention relates to a device for detecting defects on the wafer surface, said device being disposed on a stage which can be displaced in two mutually perpendicular directions.

During the fabrication process in semiconductor production, wafers are sequentially treated in a multitude of process steps. With increasing integration density, the requirements on the quality of the structures formed on the wafers increase. To be able to check the quality of the structures formed and detect possibly present defects, corresponding requirement exists in terms of the quality, accuracy and reproducibility of the equipment components that handle the wafers. This means that in the position determination and reacquisition of the position after a special event, for example after a power outage, failure of the control software and/or emergency shut-down of the entire system, the stage that displaces the wafer in the two mutually perpendicular directions allows rapid and reliable readjustment.

The object of the invention is to provide a device for wafer inspection with which the position of the stage can be securely fixed in the event of a special event.

This objective is reached by means of a device having the features indicated in claim 1.

It is particularly advantageous if in the case of the occurrence a special event, for example a power outage, software failure or emergency shut-down of the entire system, the stage that is dis-placeable in two mutually perpendicular spacial directions is fixed in the position it occupies at that very instant.

The displaceable stage carrying a wafer that is to be inspected is air-cushioned by several air nozzles. There is provided at least one valve that is connected with at least one electric control unit. The valve is configured in a manner such that normal pressure prevails in the air nozzles when the electric control unit delivers a corresponding signal or indicates an event.

For the displacement of the stage in the two perpendicularly disposed directions, there is provided a first and a second electric drive. Both the first and the second drive are linear motors.

The stage consists of a first and a second stage element. Parallel to the first linear motor is disposed at least a first track that cooperates with a multitude of air nozzles while compressed air emerges from the air nozzles thus forming an air bearing for the X direction. Similarly, at least one second track is disposed parallel to the second linear motor which track cooperates with a multitude of air nozzles while compressed air emerges from the air nozzle thus forming an air bearing for the Y direction. When the valve is open, normal pressure prevails in the air nozzles so that the stage (or the first and second stage element) with the air nozzles rests on the first and the second track and is thus fixed in the position the stage had occupied during the generation of the signal. The valve can be disposed on the air nozzle itself or in the air line itself.

The drawing represents schematically the object of the invention which in the following will be described by reference to the figures of which:

Fig. 1 is a top view of the stage of the invention;

Fig. 2 is a side view of the stage parallel to the X direction;

Fig. 3 is a side view of the stage parallel to the Y-direction;

Fig. 4a is a detailed view of a first embodiment of the connection of the air nozzles and with the control unit;

Fig. 4b is a detailed view of a second embodiment of the connection of the air nozzles with the control unit, and

Fig. 5 is a representation of the arrangement of the stage in the entire system for wafer inspection.

Fig. 1 shows a top view of the stage 2 that is displaceable in a first direction X and a second direction Y. The first and the second direction X and Y are disposed perpendicular to one another. To move stage 2 along the first direction X there is provided a first electric drive 4. To move stage 2 along the second direction Y, there is provided a second electric drive 6. The first and the second electric drive 4 and 6 are configured as linear motors. Stage 2 consists of a first stage element 2a and a second stage element 2b. First stage element 2a is guided on at least one track 8 which is parallel to the first direction X. Similarly, second stage element 2b is guided on at least one other track 10 which is parallel to the second direction Y.

The second stage element 2b comprises several air nozzles 12 that cooperate with the at least second track 10. The first stage element 2a also has several air nozzles 14 that cooperate with the at least first track 8. Through air nozzles 12 and 14, the gas is blown out at a pressure that is higher than the prevailing normal pressure. In this manner, air nozzles 12 form an air cushion between air nozzles 12 and the second track 10, an air cushion which allows the second stage element 2b to glide on said track in nearly frictionless manner. Similarly, air nozzles 14 form between air nozzles 14 and the first track 8 an air cushion which allows the first stage element 2a to glide on said track in nearly frictionless manner. The at least one first track 8 and the first electric drive 4 are mounted on a massive block 16. In addition, on the massive block 16 there are also provided several stops 17 which limit the movement of the first stage element 2a on both sides in the X direction. On the second stage element 2b, there are also provided several stops 18 which limit the movement of second stage element 2b on both sides in the Y direction. Second stage element 2b bears a receptacle 20 for a wafer 25 (see Fig. 2). In a flexible strap 22, several supply lines (not shown) are led to second stage element 2b. In another flexible strap 24, several supply lines (not shown) are also led to first stage element 2a. The supply lines to the first or second stage element 2a or 2b are compressed air lines or electric lines. Flexible straps 22 and 24 thus make it possible for the supply lines safely to follow the movements of the first and the second stage element 2a and 2b.

Fig. 2 shows a side view of stage 2 parallel to the X direction in Fig. 1. A wafer 25 is placed on receptacle 20, the receptacle being rotatable about a rotational axis 30. First stage element 2a cooperates with several air nozzles 14 and the at least first track 8. Through air nozzles 14 gas is blown gas at a pressure that is higher than the prevailing normal pressure. In this manner, an air cushion is formed between air nozzles 14 and first track 8 which air cushion allows first

stage element 2a to glide along first track 8 in nearly frictionless manner. The move-ment of first stage element 2a is limited on both sides by stops 17.

Fig. 3 shows a side view of stage 2 parallel to the Y direction in Fig. 1. Second stage element 2b is displaceable along second track 10. Second track 10 cooperates with the several air nozzles 12 that are provided on second stage element 2b. By means of the gas emerging under pressure, air nozzles 12 generate an air cushion on which second stage element 2b glides along second track 10. The movement of second stage element 2b is limited on both sides by stops 18. Moreover, stage 2 comprises a control unit 27 whereby the electric elements or the air supply to air nozzles 12 and 14 are regulated and controlled. As shown, for example, in Fig. 3, a flexible strap 22 is led to second stage element 2b. In or on the flexible strap there are provided corresponding electric lines or air supply lines extending from control unit 27 to second stage element 2b or to the air nozzles 12 thereof.

Figures 4a and 4b show a schematic representation of a valve 29 that cooperates with one of air nozzles 12 or 14. Valve 29 is connected with control unit 27 and is configured in a manner such that it provides normal pressure in air bearings 12 and 14 when electric control unit 27 delivers a corresponding signal. Control unit 27 generates a signal when, for example, the software fails, the power supply to the system fails and/or an emergency shut-down of the entire system is initialized. Figures 4a and 4b each show an air nozzle 12 or 14 that cooperates with track 8. To those skilled in the art it will be evident that an air nozzle was selected for the representation of the invention and that for all other nozzles a corresponding action relationship applies. Fig. 4a shows a first embodiment of the invention. Here valve 29 is disposed directly on air nozzle 14. Air nozzle 14 is connected to control unit 27 by at least one air line 32. Through air line 32, air nozzle 14 is supplied with compressed air. Valve 29 is connected with control unit 27 also by an electric line 34. The electric line delivers to valve 29 a signal causing valve 29 to open and providing normal pressure in the air bearings. By establishing normal pressure, air no longer exits from the nozzles and both the first and the second stage element 2a and 2b are made to rest on tracks 8 and 10. Fig. 4b shows the embodiment according to which control unit 27 inserts valve 29 in air line 32 into air nozzle 14. As shown in Figures 1 and 2, first and second stage element 2a and 2b are connected with flexible straps 22 and 24 which lead the at least one electric line 34 and the at least one air line 34 from the control unit to air nozzles 12 and 14 of the air bearings or to the first and second stage element 2a and 2b.

Flexible straps 22 and 24 exert on the first and the second stage element 2a and 2b a force that can readily be overcome by the energized linear motors. If, for example, there is a power outage in the linear motors, the mechanical force of the flexible straps 22 and 24 would suffice to move the first and/or second stage element 2a and 2b. When inspecting wafers or semiconductor substrates, it is particularly important that the position of stage 2 or of the first and second stage element 2a and 2b be known at all times. If in the event of a power outage or emergency shut-down stage 2 were to move without a record of the position data, then when the system is restarted the wafer could be damaged, because said wafer must be transported back in cassettes (not shown) allocated to the system.

Fig. 5 shows a representation of the arrangement of stage 2 in the overall system 100 for wafer inspection. System 100 is surrounded by a housing 40 and is divided into a first section 42, a second section 44 and a third section 46. Housing 40 is closed by walls (not shown) on all outer surfaces so that inside housing 40 certain clean room conditions prevail. In first section 42 of housing 40 there are disposed in essence several illumination devices 51 and at least one detec-tion device 52. First section 42 is separated from second section 44 by a mounting plate 60. The light from the illumination device 51 is guided via optical means 61 through the mounting plate 60 all the way to the surface of the wafer to be inspected. In the second space is located stage 2 which, as already indicated in the description of Figure 1, is displaceable in the X and Y directions. Stage 2 is mounted on a separating plate 70 which separates the second and the third section 44 and 46 from one another. Third section 46 surrounds several control units 27 or computers responsible for the guidance, control and regulation of system 100 and of the individual components of the system. In addition, these devices can also acquire and evaluate data.